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Research Paper

Waste Analysis of Ready Mix Concrete Production

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Abstract
Construction industry is a major contributor to global warming, for example, buildings are responsible for around 36% of energy consumption and 39% of GHG emissions. The main problem in construction activities is the process that produces waste, which of course can have a negative impact on the environment if not handled seriously. This study aims to determine the waste that occurs in the process of producing ready mix concrete and the root causes of the waste. The data used in this study are questionnaire, interviews and field observations. Based on the research results, it is known that the largest waste is defect waste with a score of 54.12% and the smallest waste is processing waste with a score of 39.76%.

Keywords: *Ready mix concrete, Waste, global warming*

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I. Background

The construction industry is one of the vital sectors of the global economy that provides infrastructure and other resources on which other economic sectors rely. The construction industry is a major contributor to global warming, for example, buildings are responsible for around 36% of energy consumption and 39% of GHG emissions (UNEP, 2017). The main problem in construction activities is the process that produces waste, which of course can have a negative impact on the environment if not handled seriously. Construction activities such as construction and demolition can produce relatively large amounts of waste, for example in the United States, construction waste reaches 1/3 of the total waste generated (Kilbert, 2007).

One example of an industry that produces waste is the ready mix concrete industry. Along with the development of construction projects, the demand for ready mix concrete is increasing. Ready mix concrete is ready-mixed concrete produced in a batching plant as a special place or factory for the process of mixing concrete materials consisting of cement, sand, water, and split in large volumes or doses. Ready mix concrete is considered more profitable than manual cast concrete. This is because ready mix concrete has advantages in the accuracy of the concrete mix and saves more time on project work (Fitriati, 2006).

PT. Waskita Beton Precast Batching Plant Jakabaring Palembang is a production company engaged in the manufacture of ready mix concrete in the city of Palembang. In an effort to increase efficiency and productivity along with the flow of the production process, it is necessary to analyze how to eliminate or reduce waste to increase production efficiency and productivity. Riyadi (2014) stated that Just-in Time (JIT) defines waste into eight types of waste, where the waste does not provide added value. The types of waste in question include several things, including excess production (over production), waiting time (waiting time), transportation (transportation), excess processing (processing), excess inventory (inventory), unnecessary movement (motion), and defective product. The JIT concept seeks to eliminate all forms of waste in the form of non-value-added activities and increase value-added activities. Therefore, this study aims to determine the waste that occurs in the process of making ready mix concrete and the root causes of the waste.

II. Research Methods

In this study, questionnaires and interviews with related parties were used for obtaining data. The questionnaire was compiled and distributed to PT. Waskita Beton Ready mix in Jakabaring, Palembang. Likert scale was used in questionnaire so that respondents' answers can be directed. Questions were arranged based on variables that have been summarized based on various literature studies and previous research. The research variables can be seen in Table 1.

Table 1 Research Variables

Variable		Sub-variable	Source
Transportation	X1.1	Storage distance with far production site	
	X1.2	The place of production with the place of quality testing is far apart	Daonil (2012)
	X1.3	Slow production flow due to production floor layout	
	X1.4	Frequently moved raw materials	Sugiantri (2015)
	X1.5	The area is too large so it slows down the production flow	Jakfar (2014)
	X1.6	Inventory is on the transport line	
Unnecessary inventory (unnecessary inventory)	X2.1	Addition of raw material storage area	Yadikusumah (2012)
	X2.2	Production accumulation	
	X2.3	Raw material accumulation	
	X2.4	Stock of raw materials is more than demand	
	X2.5	Ordering raw materials in bulk	Sugiantri (2015)
	X2.6	The remaining raw materials are still stored	Setyastuti (2017)
	X2.7	Unused/damaged tools are still available at work	
Unnecessary motion	X3.1	Ineffective layout	Jakfar (2014)
	X3.2	Difficulty finding raw materials	
	X3.3	Less strategic production area	
	X3.4	Location of storage of tools with raw materials far apart	
	X3.5	Frequent operator switching	Daonil (2012)
	X3.6	Lack of employee skills	
	X3.7	Inexperienced employees	
	X3.8	Not good cooperation	Sugiantri (2015)
	X3.9	No employee evaluation	
	X3.10	Need for additional employees	
	X3.11	Lack of supervision on the production process	
Waiting time	X4.1	Delay in arrival of raw materials	Setyastuti (2017)
	X4.2	Old tool set-up	
	X4.3	Long waiting time	
	X4.4	Waiting for work instructions	Yadikusumah (2012)
	X4.5	Broken tools/machines	
	X4.6	Machine repair that takes a long time	
	X4.7	Lack of employees	
Overproduction	X5.1	Excess production due to reduced machine usage	Daonil (2012)
	X5.2	Production process that does not match the production schedule	
	X5.3	Completion of the production process that is not according to schedule	
	X5.4	Broken machine	Yadikusumah (2012
	X5.5	Overproduction due to excess material	
Improper processing (inappropriate processing)	X6.1	Unscheduled work	Yadikusumah (2012
	X6.2	Not having an efficient work plan	
	X6.3	Inappropriate working method	
	X6.4	Lack of communication between employees	
	X6.5	Production rework	
	X6.6	Lack of supplier selection	
	X6.7	Suppliers that do not meet standards	
	X6.8	Lack of communication with suppliers	
	X6.9	Large number of suppliers	
Defect (defect)	X7.1	Unscheduled raw material checking	Daonil (2012)
	X7.2	Unscheduled production checks	
	X7.3	Non-routine checking of raw materials upon arrival	
	X7.4	No re-checking of the remaining raw materials	Daonil (2012)
	X7.5	Broken raw materials	Daonil (2012)
	X7.6	Lack of machine maintenance	
	X7.7	Quality check on the production process	Daonil (2012)
	X7.8	Insufficient quality check	
	X7.9	Error sending production results	Setyastuti (2017)

The questionnaire was designed to find out the types of waste that exist and how much waste the company has. Questionnaires were then distributed to employees of the company PT. Waskita Beton Ready mix Palembang. In addition to distributing questionnaires, interviews with related parties were also conducted to obtain the data needed for research. The data obtained from the results of the questionnaire were then processed using Microsoft excel and SPSS ver 25. The data processing process in this study was carried out with a validity test which was useful to determine whether or not the questions given to the research respondents were valid. The reliability test was used to determine the consistency of respondents in answering questions related to questions. The reliability

test was carried out by calculating Cronbach's alpha. From the test results, the average value of the answers filled in by the research respondents was calculated. The calculated average value becomes a reference in the discussion of waste identification. The average value of the sub-variable was then identified and the sub-variables were ranked based on the index of the highest to the lowest value to findthe indicators and causes of the variable.

III. Results and Discussion

The identification of waste at PT. Waskita Beton Precast Batching Plant Jakabaring Palembang were identified based on the concept of wastes on lean construction. The waste was categorized as seven groups such as overproduction, waiting time, transportation, inappropriate processing, unnecessary motion, unnecessary inventory and defects. The following is a description of the analysis and data processing for each category of waste contained in the ready mix concrete production process at PT. Waskita Beton Precast Batching Plant Jakabaring Palembang.

Table 2 Type of waste

Variable		Sub-variable	Average value
Transportation	X1.1	Storage distance with far production site	1.71
	X1.2	The place of production with the place of quality testing is far apart	2.06
	X1.3	Slow production flow due to production floor layout	2.00
	X1.4	Frequently moved raw materials	3.82
	X1.5	The area is too large so it slows down the production flow	1.94
	X1.6	Inventory is on the transport line	1.53
Unnecessary inventory (unnecessary inventory)	X2.1	Addition of raw material storage area	1.41
	X2.2	Production accumulation	1.24
	X2.3	Raw material accumulation	2.24
	X2.4	Stock of raw materials is more than demand	2.41
	X2.5	Ordering raw materials in bulk	3.76
	X2.6	The remaining raw materials are still stored	3.71
	X2.7	Unused/damaged tools are still available at work	2.12
Unnecessary motion	X3.1	Ineffective layout	1.65
	X3.2	Difficulty finding raw materials	1.53
	X3.3	Less strategic production area	1.41
	X3.4	Location of storage of tools with raw materials far apart	2.53
	X3.5	Frequent operator switching	1.65
	X3.6	Lack of employee skills	2.29
	X3.7	Inexperienced employees	1.59
	X3.8	Not good cooperation	2.59
	X3.9	No employee evaluation	3.41
	X3.10	Need for additional employees	2.53
	X3.11	Lack of supervision on the production process	2.53
Waiting time	X4.1	Delay in arrival of raw materials	3.53
	X4.2	Old tool set-up	2.53
	X4.3	Long waiting time	3.71
	X4.4	Waiting for work instructions	2.47
	X4.5	Broken tools/machines	2.53
	X4.6	Machine repair that takes a long time	2.47
	X4.7	Lack of employees	2.35
Overproduction	X5.1	Excess production due to reduced machine usage	1.47
	X5.2	Production process that does not match the production schedule	2.18
	X5.3	Completion of the production process that is not according to schedule	3.35
	X5.4	Broken machine	2.47
	X5.5	Overproduction due to excess material	2.76
Improper processing (inappropriate processing)	X6.1	Unscheduled work	1.65
	X6.2	Not a good work plan	1.65
	X6.3	Wrong working method	1.59
	X6.4	Lack of communication between employees	2.35
	X6.5	Production rework	1.47
	X6.6	Lack of supplier selection	2.76
	X6.7	Suppliers that do not meet standards	2.65
	X6.8	Lack of communication with suppliers	2.65
	X6.9	Large number of suppliers	1.88
Defect (defect)	X7.1	Unscheduled raw material checking	3.53
	X7.2	Unscheduled production checks	3.65
	X7.3	Non-routine checking of raw materials upon arrival	2.06
	X7.4	No re-checking of the remaining raw materials	3.47
	X7.5	Broken raw materials	2.35
	X7.6	Lack of machine maintenance	2.35
	X7.7	Quality check on the production process	2.24

	X7.8	Insufficient quality check	2.06
	X7.9	Error sending production results	1.35

1. Transportation

Based on the results of the questionnaire analysis as shown in Table 2, the waste that most often occurs in the transportation variable is raw materials that are often moved with an average value of 3.82. The frequent movement of raw materials makes the movement of raw materials becomes longer so that it can cause losses in time, effort and production costs. This was then categorized as waste. Waste on time can be in the form of delaying the start of the production process, waste on energy can be in the form of using machines and operator workers, and waste on costs can be in the form of equipment fuel costs.

2. Unnecessary inventory

Ordering raw materials in large quantities is the significant waste based on the analysis for the category of inventory that is not needed (unnecessary inventory).Based on the Just-in Time Purchasing concept, material orders should be adjusted based on needs in accordance with the right amount and time so that there is no accumulation of materials on location or in storage. In fact, inventory is not only seen as a waste but as something that is directly related to the company's ability to compete.

3. Unnecessary motion

Unnecessary movements can be shown by workers and tools that move in the production process but do not add value to the production process. Based on Table 2, it can be seen that poor cooperation and without evaluation of employee performance are the most significant waste categorized for unnecessary motion at PT. Waskita Beton Precast Batching Plant Jakabaring Palembang.

4. Waiting time

Waiting time is waste that can be caused by waiting for suppliers, waiting for work orders from superiors, and machine or tool disturbances that can cause delays in the production process. Based on Table 2, the main waste is caused by frequent delays in raw materials from suppliers which causes production delays. Based on the interviews, it can be seen that the preparation of production time takes a long time, causing delays in production time. This can result the delay of production schedule, leading to delays in the delivery of process production. The set-up time required is approximately 1.5 hours, including the preparation of production machines, tools and employees.

5. Overproduction

The overproduction can be caused by the addition of production results. The production process is not based on schedule or could be caused by machine damage indicating as waste. Concrete production completed before a predetermined schedule includes waste because this factor can cause excess production in storage. Storage resulting from production is included in excess production waste if it is not immediately sent to the customer.

6. Improper processing

Improper processes are caused by work conducted not based on the work plan and schedule. In this study, the waste was shown by the lack of a selection process for suppliers and also suppliers not meeting the standards. This is a waste that most often occurs at PT. Waskita Beton Precast. Therefore, it is necessary to first select suppliers that have the potential to support effectiveness and increase productivity in this company.

7. Defects

Defects during the concrete production process can be caused by poor materials, damaged tools and machines and human error. The waste categorized in this group is the lack of scheduled checking of raw materials and checking of production results. This results in the emergence of waste for the category of defective materials. This is because the company does not implement quality checks for the production process. Quality checks for ready mix production are carried out after the production process. The following is a graph of the recapitulation of waste results at PT. Waskita Precasct Batching Plant Jakabaring with values from the largest to the smallest.

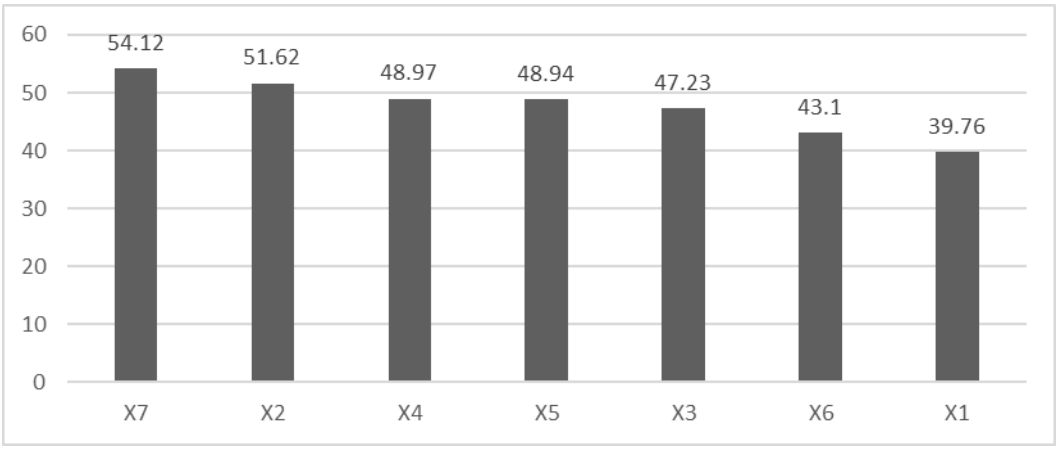

Figure 1. Percentage of waste in the company

Based on Figure 1, it is known that the largest waste is Disability waste (X7) with an assessment of 54.12%. Unnecessary storage waste (X2) the result of the assessment is 51.62%. Waste on unnecessary moves (X4) with 48.97%. Waste \ excess production score (X5) with a rating of 48.94%. Waste on transportation (X1) with a rating of 47.23%. Waste in waiting time (X3) with 43.10% and the lowest waste in inappropriate processes (X6) with 39.76%.

Based on the results of questionnaires and interviews in the field, the problem of the occurrence of waste are:

1. The occurrence of delays in the ready mix production process caused by delays in the delivery of raw materials by suppliers. This can be caused by the remote location and unsupportive transportation conditions.
2. Lack of supervision by the head of production can cause the activities of employees or workers to become uncontrolled, leading to an inaccurate schedule or production process.
3. The process of repeating the transportation of raw materials often occurs. This is due to a less strategic company layout where the location of the raw materials and the place for making concrete are quite far away. This repetition causes additional working time, excessive use of power and machines.
4. Quality checks at this company are not based on schedule. Quality checks are carried out only when receiving raw materials, while the remaining raw materials are not rechecked. Scheduled quality checks should be carried out because regular quality checks can prevent production defects caused by poor raw materials.

IV. Conclusion

The identification of waste for the ready mix concrete production process at PT. Waskita Beton Precast Batching Plant Jakabaring Palembang can be defined as below in which defective waste (X7) with a value of 54.12%,unnecessary 51.62% for storage waste (X2), 48.97% for unnecessary movements (X4), 48.94% for excess production (X5),47.23% for transportation (X1), 43.10% for waiting time (X3), and 39.76% for improper processes (X6).

This company has a lot of waste such as accumulated residual material, excess production of ready mix concrete which is carried out to anticipate sudden orders, production delays caused by tool set-ups that tend to be long, and quality checks are not routine and unscheduled. To achieve effectiveness and efficiency in the company, the company needs to eliminate waste in the company. Based on the results it was found that the occurrence of delays in the ready mix production process caused by delays in the delivery of raw materials by suppliers. This can be caused by the remote location and unsupportive transportation conditions. Quality checks at this company are not based on schedule. Quality checks are carried out only when receiving raw materials, while the remaining raw materials are not rechecked. Scheduled quality checks should be carried out because regular quality checks can prevent production defects caused by poor raw materials.

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